Estimating and explaining the efficiency of township hospitals in Shandong province in the context of the drug policy reform

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1. Abstract and objective of the paper[1]

To cope with the rising price of drugs, in 2009 the Chinese government launched a large pharmaceutical reform. Its key element is the implementation of a National Essential Medicine List, leading to a reorientation of incentives for health services providers. Health facilities are not anymore allowed to make any profit on drug sales ("zero mark-up policy"), while this used to be their main source of financing. Different compensation schemes have been implemented by the authorities. In a context of explosion of subsidies, it is crucial to understand how the reform has impacted –or not- health care facilities activity and efficiency.

This study relies on a survey data from a sample of 30 Township Hospitals, the first reference level of the Chinese Health system, in the rural prefecture of Weifang (Shandong province). Using a two-stage procedure, this paper aims at assessing the THs' technical efficiency scores and then to identify the determinants of this efficiency. The first stage is realized with the new non-parametric frontier approaches, the so-called 'partial frontier' methods, order-m and order- α to deal with the problem of dimensionality. The identification of the determinants of efficiency requires panel data models, with random individual effects. The most significant and robust factors are demand-side variables, rather than internal ones, suggesting that the current barrier to universal access to healthcare can be related to the demand side of the healthcare system: out-of-pocket payments from patients, perception of quality of public healthcare.

2. Background

From 1975 to the early 2000's, the Chinese rural population saw its basic care system deteriorated, mainly due to the disentangling of the Cooperative Medical System, which almost ensured a universal coverage of the rural population. In 2003, the implementation of the New Rural Community Medical System (NRCMS) gave a large part of rural households an access to a basic health insurance, managed at the county level. From 2003 to 2010, the enrollment rate rose from less than 10% up to more than 90 % (*WB Policy Note 3,*[2] Yip et al., 2012).

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[2] (Yip et al. 2012)

However, the NRCMS almost only aimed at avoiding catastrophic health expenditures, in order to prevent households from falling or sinking deeper into poverty. NRCMS are ruled at the county level. The counties manage their benefit package within a policy guideline[3], focusing mainly on inpatient care. The deductibles and the copayments rates remain high in many counties, leaving high out-of-pocket payments for most of the medical acts. Health expenditures remain a financial burden in the households' budget, especially outpatient expenditures, which are still poorly reimbursed by the insurance.

At the same time, on the supply side, the financing scheme of health providers had spurred overpricing and overprescribing for many years. Central subsidies to public health care facilities fell off, and to offset it, hospitals were allowed to take a markup on drug sales and 'new' medical acts such as tests and surgeries). Simultaneously, there was a severe control of the price of 'basic'[4] cares, on which health facilities could not make any profit. Those phenomena put together created incentives for health practitioners to overprescribe high-technology tests and expensive drugs rather than cheaper ones, to increase the TH income, through user fees. Drug benefits became the main source of hospitals financing[5]. Until 2009, health facilities were allowed to take a 15% mark-up on the drug purchasing price, and used to actually "take an average margin between 30% and 40%" (Wang Dongsheng, vice-director of the Social Development Division of National Development and Reform Commission in 2006). This made the financial burden of health expenditures even heavier for households. On the contrary, basic care services were neglected by health providers, enhancing a problem of quality of primary health in addition.

Drug overpricing was also spurred by the national drug supply chain, due to the excessive number of wholesalers, intermediaries between the drug producers and health facilities, and by the absence of bidding.[6] Indeed, in China the pharmaceutical market was made of thousands of manufactures, selling their production to a 'third-tier' who made the contact to another wholesaler, or to health facilities. Every actor of the supply chain taking a benefit, this structure participated in the very high prices of drugs in China (compared to the international prices).

3. National Essential Drug Policy

To cope with the excessive price of drugs and disconnect hospitals income from drug sales, in 2009 the Chinese government implemented the National Essential Drugs Policy (NEDP) to improve the drug supply system and ensuring both equity in the access to basic care medicines and safety of drug utilization. A National Essential Medicine List (NEML) was released at the same time, updated in 2012. It includes three medicinal categories: chemical and biological drugs (317 drugs), traditional Chinese patent medicines (203 drugs) and traditional Chinese cut crude herbs (NHFPC, 2013). To meet regional specific needs, local governments were allowed to establish an additional list of essential drugs. In Shandong province, where this study area is located, the additional list (2010 version) consists of 216 drugs. All Primary Healthcare Facilities (PHF) must now prescribe exclusively essential drugs. As for other healthcare facilities, the utilization of essential drugs should be a priority, and the rate of essential drug utilization must reach the threshold defined by health authorities (NHFPC, 2009).

[3] (You et Kobayashi 2009)
[4] (Blumenthal et Hsiao 2005)
[5] (Yip et al. 2010)
[6] (Yu et al. 2010)

Since October 2008, the government also gradually implemented a zero-markup policy for the sales of essential drugs (NDRC, 2008).The selling price in PHF has been adjusted to the purchasing price, including delivery costs and health facilities are not allowed to fix a higher selling price anymore. This policy, between 2009 and 2010, completely redefined the structure of PHF financial balance. Indeed, the loss of drug benefits is a huge hole in PHF revenue and could have widely disturbed their daily activity.

The reform also included the development of Public Health activities: vaccinations, Health Records for children and elder people, with specific subsidies to this purpose.

4. Compensation schemes and separation of revenue and expenditure

To compensate losses due to the zero-markup policy, and ensure the stability of NEDP, different modes of financial compensation have been put in practice[7,8]. Each county can either choose one, or mix several modes of compensation among the following.

Exclusive government compensation

The PHF with a financial deficit between incomes and expenditures will have their deficits financed exclusively by county government. This compensation mode provides a guarantee for implementation of NEDP, but also a lot of financial pressure for local governments, which could impedes the financial viability of the NEDP. If subsidies are allocated unconditionally, this could lead to a strong decrease of efficiency, as health care providers know that the government will finance them without regards to their performances. This scheme is not applied in Weifang, but in some provinces as Anhui for example.

Incentive system

The financial losses are not directly compensated, instead the PHF encourage their medical staff to develop profitable activities such as surgery, or color Doppler ultrasound for instance.

Multiple compensations

They mainly come from government subsidies but also from health insurance funds, or other complementary compensations like the increase of the cost of some treatments. For example, some health facilities increased the cost of tests and injections, other health facilities created a general consultation fee, which includes the fee for consultation and the fee for injection, or a fee for drug prescription. Seven out of eight counties in the study area have adopted those multiple compensations.

In the Weifang prefecture, there are supplementary capitation subsidies for the development of public health services. In 2013, the amount of this subsidy was 30 yuans per covered inhabitant per year, which could help THs in compensating the loss of drug sales.

The separation of revenue and expenditure system

Both the revenues and the expenditures of PHF are totally managed by the county government. In other words, all the incomes of PHF are paid to the county government, and their expenses are integrated into the government budget. The government handles the wages and the cost of the zero-markup policy. This compensation mode breaks the link between revenue and expenditure, so that profit-seeking behaviors could be avoided. In the Weifang prefecture, the Anqiu county has adopted this mode of compensation. The effect of this system on efficiency is again hard to predict, depending

[7] (Yuan et Tang 2012)

[8] (Zhuo et Zou 2012)

upon whether the county government ensures a follow-up of THs activity and introduce or not some element of performance based financing.

When a financial compensation comes from the county, the performances of PHF are assessed for the attribution of the subsidies. The amounts are generally disbursed in several times such as once at the beginning of the period, once at the end. Usually, the first allocation is higher, to ensure the daily activity of PHF. In the study area, 80 % of the subsidies are allocated monthly, during the current year. The remaining 20% are disbursed in March of the next year only if the PHF meets the requirements in the assessment organized by the provincial health authority. However, leaving a TH without any financing because of its poor performances is difficult as it jeopardizes its activity for the following year. Thus, actually, the county government handles most of the financial deficits in every TH in Weifang, as long as it can afford it.

Due to the complexity of the compensation and of the incentives measures, the effects of the reform on THs efficiency are far from predictable and may seem contradictory.

5. Expected effects of the reform on TH efficiency

The mandatory use of essential drugs as well as the policy of zero mark-up should lead to a decrease in the unit cost of care and reduce catastrophic costs, all things being equal. Because of the high cost of care, we can consider that the health care demand at TH level is relatively price elastic, more precisely, elastic to the amount of the residual cost borne by the households. For these reasons, and if the rate of reimbursement by NCMS does not decrease, we should expect an increase in health care demand, all things being equal. It may be a demand that was not expressed previously (renunciation to care and self-medication, only care provided at village facilities level) or a transfer of demand from station health villages or district hospitals. An additional possibility is that patients, noting the decrease in unit costs, engage in a process of more sophisticated care, which they would be given up if there was no decrease in unit costs. An almost similar effect was highlighted in Gansu province following the development of NCMS[9].

If activity is expected to rise over the period, the link between the pharmaceutical reform and technical efficiency is not that obvious. Pélissier (2012) exhibits a positive and significant impact of the NRCMS TH activity in Weifang, but a negative impact on their efficiency. The evolution of the two variables are two distinct issues.
Although we expect an increase in demand, three main broad scenarios (with variants) can be considered, suggesting that the effect of the reform on the efficiency of TH is unknown a priori:

i) Demand for care increases, all other things being equal: efficiency progress is noted.
ii) Demand for care increases, but its expected positive effect on efficiency is offset by an increase in the number of staff and other inputs. To anticipate and promote increased attendance in TH, the authorities may have decided to increase the number of staff, although recent studies[10] have highlighted the low staff productivity. If the demand does not increase sufficiently, the effect on the efficiency is potentially negative. It seems likely in Weifang, regarding our discussion with the local authorities.

[9] (Wagstaff et Yu 2007)
[10] (Audibert et al. 2013)

iii) Demand remains unchanged as does the level of personnel and equipment. A decline or stagnation of efficiency is expected for several reasons:

a) Compensation for loss of income from drugs is partial; demand remains unchanged because THs develop coping strategies, for example by increasing medical activities (lab tests, etc.) that are not supervised by the reform. The unit cost of care borne by households does not decrease. It is thus crucial to determine whether subsidies have offset the drug incomes, and to determine if the incentives to spur activity are effective. Understanding the compensations and coping strategies implemented by health care providers (excessive prescriptions of injections and tests for instance) is another stake of the analysis of the pharmaceutical reform[11].
b) Cost of care decreases. If there is partial compensation, and without THs coping strategies, objective and/or perceived quality of care are likely to decline. The negative effect on demand neutralizes or outweighs the positive one coming from the decrease in the cost of care borne by households.
c) Compensation is greater than the loss of income from drugs. THs operate in a context of soft budget constraints. Quality of care deteriorates. As above, the quality effect can outweigh the price (cost) effect.
d) There are shortcomings in the availability of essential drugs. The demand effect on efficiency is comparable to the previous point.

6. Estimating efficiency of Township Hospitals

Assessing the technical efficiency of hospital induces to identify first its production function, before discussing the efficiency model.

6.1 The choice of the production function

The definition of the production function has been made according to observations, and discussion with local actors. As a hospital production is a multi-outputs function, a synthetic indicator is needed for the efficiency assessment. Seven variables were selected as representative of an aspect of the TH's activity: outpatients, admitted inpatients, emergencies, surgeries, tests and vaccinations and antenatal consultations. A Principal Component Analysis was computed in order to get some synthetic factors of the TH activity.

The first factor of the PCA was kept as the output in the production. It is by far the most explanatory axis, and it is positively correlated to each of the variables introduced, traducing a global activity trend. This axis is consistent with what we expected for the production function, so it is kept as the Global Activity Index and used as the output of our model.

A second axis was found to be relevant in the PCA. It was positively correlated to three of the variables: the number of antenatal consultations, of vaccinations and of emergencies, and negatively correlated to the others. Furthermore, the Eigen value associated to this vector is much lower than to the first one. For those two reasons, this axis cannot be introduced as a second output, because of this negative correlation. It would mean that an increase of vaccinations for instance would lower the value of one of the two outputs, which makes no economic sense. Nevertheless, this axis can give information about the "profile" of each TH. Indeed, the healthcare reforms in Weifang include the

[11] (Xiao et al. 2013)

development of Public Health activities, and the three variables positively correlated to the second axis are part of those activities.

Three inputs were identified, reflecting the human and physical capital of the TH: the number of available beds, the staff of the TH, and an equipment index. This latter was computed using a Principal Component Analysis (PCA) which included every kind of imaging and test machine found in a TH[12].

6.2 Measurement of efficiency

There are mainly two ways of assessing health facilities efficiency: a parametric one, the Stochastic Frontier Analysis (SFA), and non-parametric ones such as the Data Envelop Analysis (DEA). As pointed out by Hollingsworth and Pélissier [13], the Data Envelopment Analysis (DEA) method has been widely used in assessing health facilities efficiency since its apparition in 1978[14]. It avoids making any assumptions about the form of the production function, when it is unknown.

Nonparametric efficiency methods can only compare DMUs (Decision Making Units) of the sample. The best performers of the sample will be defined as the efficient units and assessed a score of 1, and will be benchmarks for the other DMUs. This method is the most represented in the literature on health sector efficiency[15][16]. The problem of the DEA method relies in its sensitivity to dimensionality, and to outliers in the considered sample. If there is an outlier in the sample, the production frontier is distorted, and the scores of all the DMUs compared to those wrongly or artificially efficient units are biased.

Various attempts have been made to cope with this sensitivity. Particularly, the so-called 'partial frontier' methods brought to the efficiency assessment new tools to deal with the limits of the DEA.

The first one is the order-m frontier, introduced by Cazals et al.[17]. To estimate the efficiency of a DMU in an output orientation, many samples of *m* DMU are simulated, composed of DMUs using at most the same quantities of outputs in the sample (in an input orientation, producing at least the same quantities of outputs). For each simulated sample, an efficiency score is assessed to every firm, relatively to the estimated frontier. The procedure is repeated *n* times, then the mean score of all those simulations becomes the order-m score. This method authorizes DMUs to be above the production frontier, and the scores to be above 1. It is also a way to detect outliers, defined as the DMUs whose score remains largely above 1 even when *m* increases.

The second type of partial frontier analysis is developed by Daouia and Simar[18], it is the so-called order-alpha scores. The logic is close to the order-m frontier, with a difference in the way of excluding observations from the sample. In the output orientation, the production frontier is there defined so that a DMU I is compared to the level of output produced by (1-α)*100 % of the firms using at most the

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[12] The PCA included the number of radiography and computed tomography machines, of echographs, electrocardiogram machines, endoscopes, anesthetic machines and ECG monitoring instruments.

[13] (Hollingsworth 2008 and Pélissier 2012)

[14] (Charnes, Cooper, and Rhodes 1978)

[15] (Birman, Pirondi, et Rodin 2003)

[16] (O'Neill et al. 2008)

[17] (Cazals Florens Simar 2002)

[18] (Daouia et Simar 2007)

same level of inputs[19][20]. Again, it is possible for an observation to get a score higher than 1, meaning that the firm performed better than the partial estimated frontier. Considering the size of our sample, there is a concern about dimensionality, and some outlying DMUs. Thus, those techniques are used here to detect the presence of any potential outlier and to have robust technical efficiency scores.

In the efficiency assessment, an output orientation was chosen. THs have limited choice concerning their inputs, the county authorities decide of their size and of the importance of the staff. In this context, their strategy can only have influence on the output level, given the level of their inputs.
The reform was implemented at the end of 2009 in 23 of 30 THs, and during 2010 in the remaining 7. It is assumed that in 2009, the production function had not changed yet, so two production frontiers are estimated: one going from 2006 to 2009, and the other from 2010 to 2012.

7. Study area and descriptive statistics

7.1 Database

This study relies on annual survey data, from the rural part of the Weifang prefecture, in Shandong province, a relatively rich coastal province. The Weifang prefecture includes 12 administrative divisions, each formed of many townships. To each township is associated one Township Hospital (TH) also called Township Health Center. The sample is made of 30 TH randomly selected, belonging to 8 of the 12 counties of the prefecture. The observation period under study runs from 2006 to 2012. Data was collected by the staff of Weifang Health Bureau, the students of Weifang Medical University and our team. Sources of data include registers of TH, Statistical and Finance Offices of townships and counties.

7.2 Important evolutions of the inputs and outputs of the TH

During this period, the level of both inputs and outputs increased. The activity of TH grew drastically regarding outpatients, inpatients, lab test, medical examinations (radiology, etc.) and preventive activities. Basic information is in Table 1**.** The evolution of the Global Activity Index confirms the dynamic development activities for almost all TH (cf. Figures 1). As example, during the period 2006-2012, the number of oupatients increased by 82%, inpatients by 126% and our Global Activity Index by 70%.

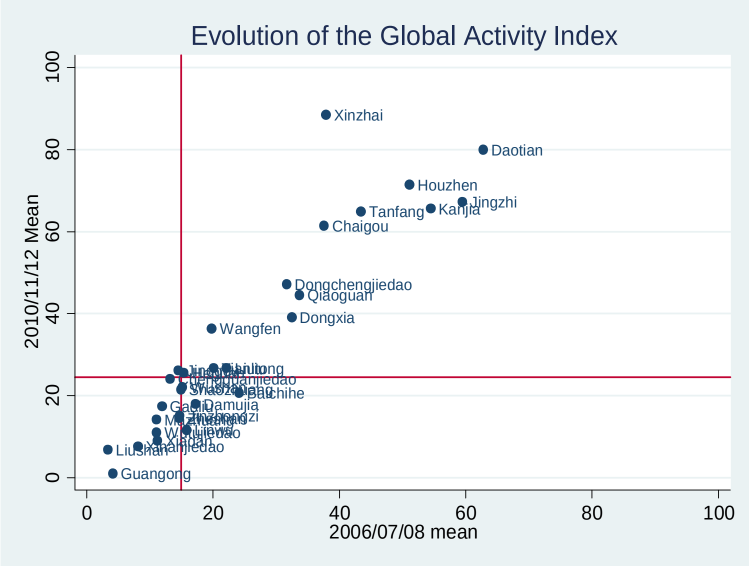
The inputs of THs also rose over the period. But the number of available beds (+75%) and the Equipment Index (+85%) grew faster than the staff (+19%). Indeed, TH managers frequently underlined their difficulties to hire staff in rural areas.

[19] (Wilson 2008)
[20] (Daraio et Simar 2007)

Table 1. Descriptive statistics

	Mean			Minimum			Maximum			Median			Standard deviation		
variable	**2006**	**Var(%)**	**2012**	**2006**	**Var(%)**	**2012**	**2006**	**Var(%)**	**2012**	**2006**	**Var(%)**	**2012**	**2006**	**Var(%)**	**2012**
Population of the township (10 000 people)	5.85989	21.78	7.1359	2.7	9.26	2.95	15.84	0.88	15.98	5.06275	32.34	6.7	2.96149	11.43	3.3
Population covered by the TH (10 000 people)	4.62	21.81	5.63	1.92	1.56	1.95	9.10	7.69	9.80	4.57	14.57	5.23	1.80	40.78	2.53
Annual net income (yuans)	5510.77	97.92	10906.9	3576.00	138.70	8536	8993	40.42	12628	5275	107.65	10953.5	1170.15	-15.25	991.74
Nb of outpatients	33087.4	82.22	60290.3	3390.00	142.80	8231	93296	154.89	237802	19612	63.07	31982	27565.6	125.75	62230.2
Nb of admitted inpatients	1510.23	125.85	3410.87	0.00		519	4063	257.45	14523	1164.00	118.90	2548.00	1024.18	184.28	2911.57
Nb of tests	5416.90	75.27	9494.33	416.00	-38.22	257	19786	80.99	35810	3319.50	105.29	6814.50	5629.36	58.35	8914.30
Nb of surgeries	172.00	26.16	217.00	0.00		0	735	37.82	1013	116.50	17.17	136.50	185.45	28.24	237.82
Nb of vaccinations	11178.1	43.15	16001.7	619.00	-60.90	242	29057	284.06	111597	11277.5	27.83	14416.0	7619.25	167.63	20391.4
Nb of antenatal consults	1678.40	0.30	1683.40	101	73.27	175	6622	-15.58	5590	1273.00	-24.19	965.00	1544.86	1.08	1561.48
Nb of emergencies	605.23	119.95	1331.23	0		0	5421	49.92	8127	156.50	137.06	371.00	1143.68	88.08	2151.02
Global Activity Index	21.33	69.87	36.24	1.47	-100.00	0	58.70	70.37	100	14.95	63.98	24.51	14.69	83.92	27.03
Nb of available beds	44.27	74.55	77.27	0.00		20	100	80.00	180	38.00	60.53	61.00	24.30	88.99	45.92
Staff of the TH	64.83	18.46	76.80	23.00	4.35	24	150	24.67	187	56.50	19.47	67.50	35.92	11.75	40.14
Equipment Index	22.61	84.59	41.74	0.00		12.85	54.66	82.97	100	21.37	68.94	36.11	14.00	76.28	24.68

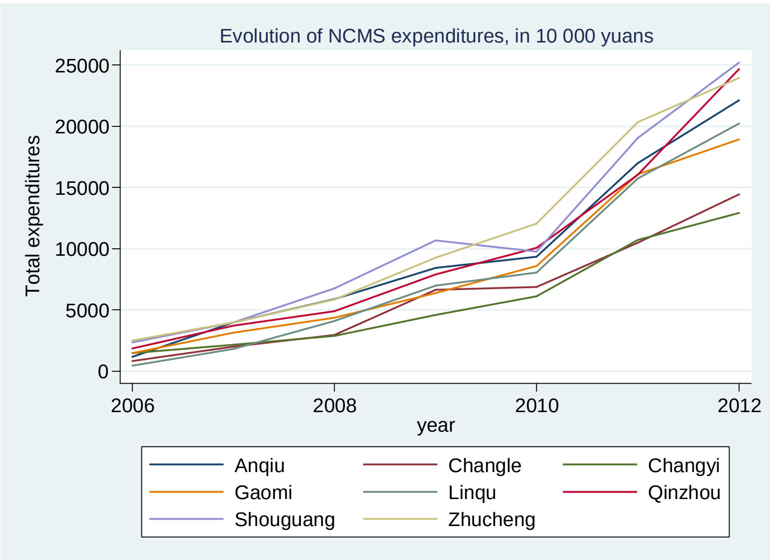
Figure 1. Evolution of the Global Activity Index



Source: Authors database

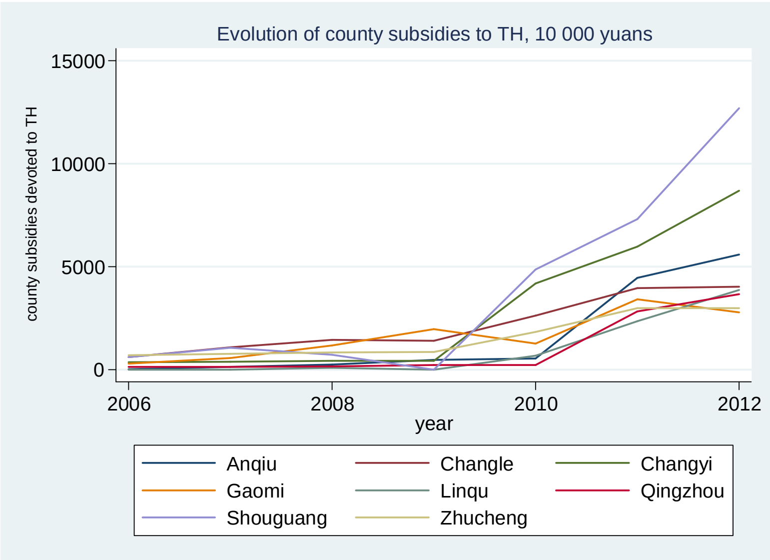
At the same time, the expenditures of every NRCMS Bureau in our sample constantly increased, with a strong acceleration starting from 2010, as well as the county subsidies devoted to the THs (Figures 2 and 3), contributing to ensure a quasi universal coverage for a selected package of outpatients and inpatients care. In Shouguang, where subsidies to TH increased the most, they have been multiplied by 10 in 3 years. For the growth of NRCMS expenditures, there are mainly two complementary explanations, linked to the deepening of the benefit package: the number of outpatient reimbursements increased, and the mean reimbursement per inpatient case also raised. Those elements certainly spurred the increase in TH's activity, as the literature generally provides evidence of a positive influence of health insurance on the demand for care.

Figure 2. Evolution of NCMS deflated expenditures



Source: Authors database

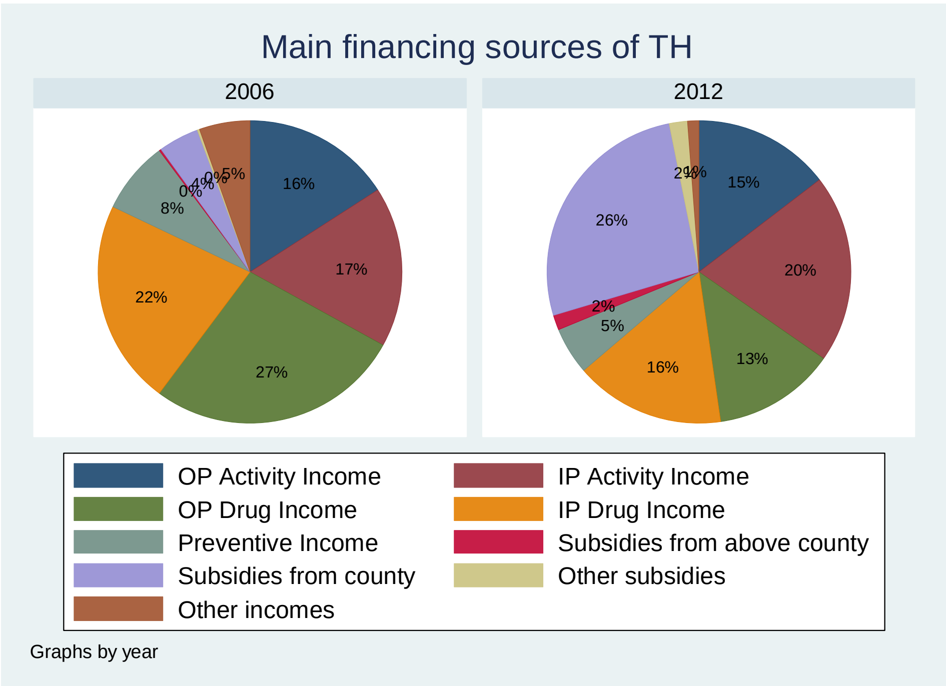
Figure 3. Evolution of deflated county subsidies to TH



Source: Authors database

As stated previously, the NEDP (National Essential Drugs Policy) reform sharply changed the income structure of PHF. Figure 5 shows the comparison of principal sources of income for all observed TH between 2006 and 2012. In 2006, over 80% of revenues came from hospitals' activities, such as inpatient activity, outpatient activity and drug prescription. Furthermore the drug prescription was the primary source of income, nearly the half of the total income. In contrast, activities rewarded hospitals up to 55% of its revenues in 2012. This huge decrease originated almost exclusively from the share of drug prescription. This lack of revenues was replaced by governmental subsidies, especially the subsidies from county level, which represented one third of hospitals' revenues.

Figure 4. Main financing sources of TH



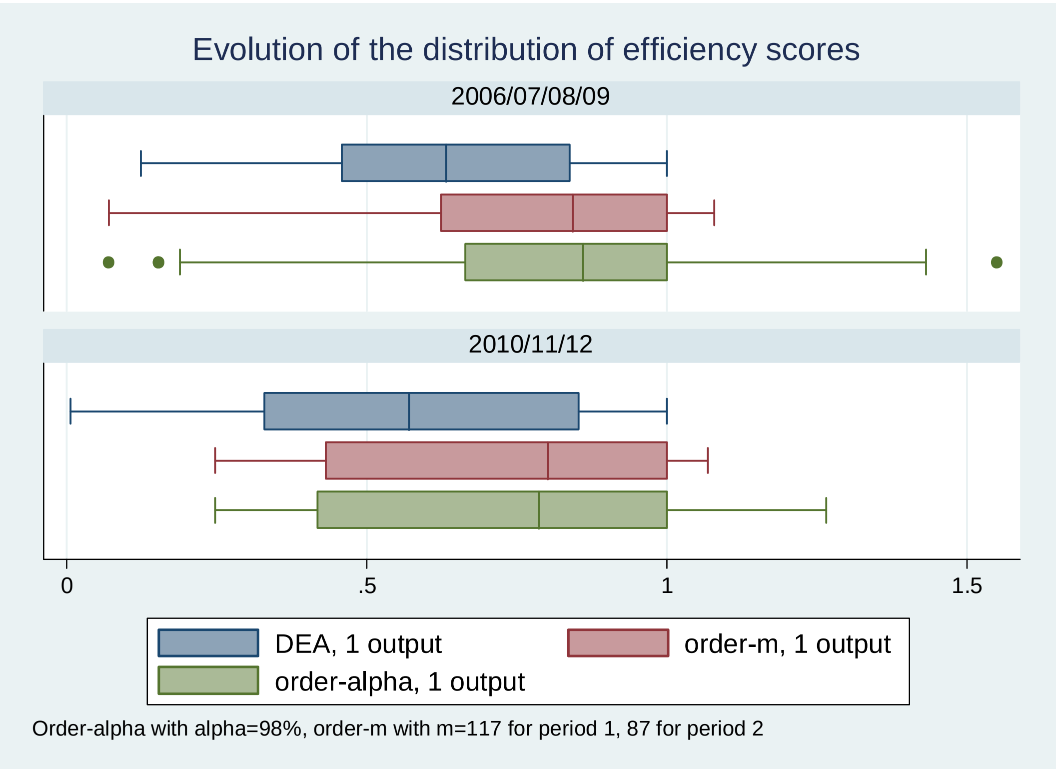
Source: Authors database

7.3 Efficiency scores

The analysis of the scores obtained with the robust frontier method indicates that there is no outlier in our sample (there is no observation with an order-m score higher than 1.5; Figure 5). The correlation between the order-m and order-alpha scores is very high, both for the first and the second period (coefficient always superior to 0.9). A Spearman coefficient confirms that the ranking of the TH is almost the same with the two methods. The "Speaman's rho" is superior to 0.9 in both of the two sub-periods, and equal to 0.94 on the whole period. But the order-alpha scores exhibit a higher number of "super-efficient units", of TH with a score higher than 1.

Technical efficiency decreased over the period. The average efficiency reaches a peak in 2007 and then decreases until 2012 (Table 3). The number of very inefficient THs has increased between the two sub-periods (table 2, 18 than 33 THs exhibit a score lower than 0.6). During the first sub-period, inefficient THs were closer to the production frontier.

Figure 5. Scores using DEA and robust frontier (order-m and alpha)



As expected[21], the order-m scores are very stable with value attributed to m. The order-alpha scores appeared more sensitive to a change in the alpha parameter. The order-m scores have an easier economic interpretation, and in the literature they have been shown to be more robust, and to have better statistical properties than the order-alpha scores[22]. Thus, the order-m scores were kept for the rest of the analysis, but the conclusions remain the same with order-alpha.

[21] Cazals Florens Simar 2002

[22] Daouia et Gijbels 2011

The correlation between the DEA and the order-m scores is 0.82 for both periods, and a Spearman test indicates that the ranking are not independent, with a statistic of 0.85 for 2007/08/09, and 0.81 for 2010/11/12.

Table 2. Comparison between DEA scores and Order-m scores in each studied sub-period

	Efficiency scores with order-m, 2007/08 /09						
DEA	<0.6	0.6<x<0.8	0.8<x<1	x=1	1<x<1.2	x>1.2	Total
<0.6	18	14	2	1	0	0	35
0.6<x<0.8	0	6	12	7	2	0	27
0.8<x<1	0	0	8	2	8	0	18
x=1	0	0	0	3	5	2	10
Total	18	20	22	13	15	2	90

	Efficiency scores with order-m, 2010/11/12						
DEA	<0.6	0.6<x<0.8	0.8<x<1	x=1	1<x<1.2	x>1.2	Total
<0.6	33	7	2	3	2	1	48
0.6<x<0.8	0	4	7	1	3	0	15
0.8<x<1	0	0	5	0	7	0	12
x=1	0	0	0	10	5	0	15
Total	33	11	14	14	17	1	90

Table 3, evolution of efficiency scores

year	mean	min	max	p25	p50	p75	sd
2006	0.747	0.071	1.064	0.499	0.835	0.991	0.275
2007	0.788	0.153	1.067	0.573	0.874	1	0.258
2008	0.765	0.154	1.079	0.645	0.804	1	0.239
2009	0.778	0.189	1.052	0.646	0.853	1	0.252
2010	0.736	0.248	1.068	0.458	0.825	1	0.291
2011	0.728	0.277	1.068	0.432	0.819	1	0.279
2012	0.710	0.269	1.051	0.404	0.696	1	0.288

8. Estimating the determinants of THs efficiency

8.1 The empirical strategy

The two-stage approach usually uses Tobit model to deal with the censored nature of the DEA scores. Here, data is not censored due to the partial frontier scores, so the Tobit model is not required.

The partial frontier scores allow dealing with the problem of dimensionality in the efficiency assessment. To tackle the problem of possible bias due to a second-stage regression, Wilson (2007) proposes a bootstrapped linear model. Thus, a panel model is used. Random effects are chosen after running a Hausman test. In order to control for a potential correlation between the explanatory variables and the individual effects, the estimations are also performed using a Hausman-Taylor instrumentation.

8.2 The tested determinants

The literature related to the determinants of efficiency in health facilities highlights two kinds of factors. The first ones are *internal* ones: composition of the staff, financing structure for instance. Here, several variables - the proportion of licensed staff (i.e. proportion of doctors among the medical staff) and the proportion of subsidies among the TH incomes - are tested. The importance of subsidies is also introduced in another way, by the amount of subsidy allocated to the TH, per covered people. Indeed, large disparities are noticed in the allocation of subsidies.

The potential endogeneity of subsidies is to be taken into account. In theory, for the TH of our sample in Weifang, the amount of money allocated to a TH is related to its performance, so the causality would be from the efficiency to the subsidy, with a positive sign. It can also be considered that, in a situation of soft budget constraint, the relation between the two would be negative. An inefficient hospital is more likely to have a negative financial balance, and this deficit will be offset by the subsidies at the end of the period, or at the following year. In this case, the amount of subsidies is still explained by TH performances, but with a negative sign.

The analysis of relationships between the different variables, and particularly of the determinants of subsidies exhibits an absence of endogeneity between efficiency scores and subsidies allocation. Indeed, subsidies per capita are explained by two main elements: the population of the township, and the financial situation of the NRCMS. The net income per capita at the county level appears to be a significant and positive determinant of the amount of subsidies allocated to each of its TH, while the efficiency score, or the lagged efficiency score don’t explain at all the subsidies.

Other internal factors have been introduced in the model: Particularly, the second axis of the PCA was tested, to check if a certain profile (activity focused on Public Health, or on the contrary more curative) of TH was linked to the level of efficiency, with no significant results.

The second type of determinants of efficiency is the *externa*l one. It gathers all the aspects of the hospitals environment: competition of other healthcare facilities, net income per capita, density of the population for example. We use the population covered by the NCMS in the township, the density of population, the number of Village Health Centers under the responsibility of the TH. This last variable can have two opposite effects: there can be a phenomenon of competition (a negative effect), or stimulation by the referring of patients (positive effect).

To check whether this was a shift in the determinants between the beginning and the end of the period, the potential determinants were interacted with dummies corresponding to sub-periods, as well as squares to test non-linear relations.

8.3 Results

They are presented in Table 1. We found that the external factors seem to explain better than the internal ones the differences in efficiency scores.

The number of VHS appears to have a significant and negative impact on efficiency, highlighting the effect of competition between the two types of structures, rather than a phenomenon of referring. The coefficient remains very low, very close to zero, but it is very robust to the specification of the model. This is not surprising as the authorities in Weifang intend to push patients to enter the health system at the grassroots' level.

The density of population and the population itself don't have any impact on efficiency, but the number of inhabitants per bed does. This can be interpreted as a huge quantity of inputs in the Townships Hospitals, relatively to the demand of primary healthcare. The productivity is very low in the sample (per medical staff and per day, the mean number of outpatients is 1.5 in 2006 and 2.18 in 2012, and of inpatients 0.08 to 0.14), so, to increase efficiency, the demand has to grow.

Finally, the different variables representing the subsidies and the way they are allocated between the TH do not explain the technical efficiency in the sample. This can reflect the multiplicity of mechanisms at stake, which makes the identification of a unique effect difficult. A clear aspect of the reform is how it has been implemented in different ways according to the specificity of county authorities approaches and of financial capacities. A larger sample will be useful to investigate more deeply this issue, since this question would require comparing groups of THs experiencing the same mode of allocation to see which mode of allocation leads to the best incentives for the health care providers.

Still, so far subsidies haven't been positively or negatively related to the level of efficiency or to any objective criteria, so that there is no incentive for providers to improve their efficiency in order to get more subsidies. TH performances are thus driven by external factors, especially the demand of the population.

To enlarge this last idea, those results also shed the light on the financial constraint of Chinese rural households regarding healthcare. If the demand side is the prominent determinant in TH performances, it means that the enlargement of the benefit package of the NRCMS and of the reimbursement rates is crucial to spur TH activity, and not only the development of infrastructures, because for now the potential patients may still be facing financial barriers to access, although the situation has strongly improved in a decade. The benefit package of all the NCMS bureaus has been focused mainly on inpatients reimbursements to avoid catastrophic expenditures. The expenditures linked to daily outpatient expenditures were left to patients for their major part, so that the financial cost to current healthcare can remain an obstacle to access to TH health care. In Weifang, in 2006 outpatients acts were reimbursed up to 30%, and many cases were not reimbursed at all. In 2012, user fees represent at least half the cost borne by the NCMS and the patient.

In 2011 and 2012 the number of outpatient reimbursements has exploded in the NCMS bureau of Weifang. This can be the first step to a progressive improvement of the rate of reimbursement, the same progression followed by the inpatients reimbursements in primary healthcare facilities from 2003 to 2010.

9. Conclusion

Using a two-stage procedure, robust frontier methods to assess technical efficiency, and panel data models to explain it, this paper highlights the role of the demand side in the technical efficiency of primary health care facilities in the rural prefecture of Weifang. This technical efficiency decreased between the beginning and the end of the period, more THs exhibits very low efficiency scores from 2010 to 2012. It appears that, in substituting drug margins by subsidies, for now the implementation of the drug policy reform did not manage to make of the subsidies a real incentive to spur activity and efficiency of TH.

At the same time, demand side factors such as the density of covered population per available bed exhibits the fact that it is not sufficient to improve provider efficiency. To spur activity in this perspective, it is necessary that outpatient health care become more affordable and that the NCMS enlarges its benefit package towards better reimbursement of outpatient care. We should also ask whether, at least for some counties, TH are not oversized, regarding their specific position between VHS and county hospitals.

Table 4, Random effects and Hausman Taylor regressions

VARIABLES	(1) efficiency	(2) efficiency	(3) efficiency	(4) efficiency	(5) efficiency	(6) efficiency	(7) efficiency	(8) efficiency
Covered population	0.0201	0.0221	0.0219	0.0248	0.0209	0.0228	0.0232	0.0233
	(0.0184)	(0.0213)	(0.0166)	(0.0216)	(0.0144)	(0.0218)	(0.0148)	(0.0222)
Subsidies per capita	-0.00103*	-0.000328	0.000188	0.000858			0.000687	0.00103
	(0.000541)	(0.000760)	(0.00105)	(0.00111)			(0.00111)	(0.00116)
Subsidies per capita*first period							0.000864	0.000839
							(0.00500)	(0.00622)
Prop of licensed staff	0.369	0.462	0.380	0.490	0.483*	0.469	0.357	0.311
	(0.302)	(0.343)	(0.321)	(0.382)	(0.280)	(0.412)	(0.307)	(0.395)
Nb of VHC	-0.00402*	-0.00382	-0.00428**	-0.00423*	-0.00371*	-0.00412*	-0.00439**	-0.00465*
	(0.00210)	(0.00259)	(0.00189)	(0.00252)	(0.00200)	(0.00227)	(0.00187)	(0.00244)
Staff exp per capita	0.0126	0.0141	0.0112	0.0115	0.0158	0.0137	0.00527	0.00429
	(0.00962)	(0.0126)	(0.00960)	(0.0120)	(0.0106)	(0.0122)	(0.0103)	(0.0126)
Staff exp per capita * 1rst period							0.0125	0.0126
							(0.00846)	(0.00897)
Prop of subsidies			-0.226	-0.242	-0.114	-0.144	-0.195	-0.262
			(0.172)	(0.196)	(0.142)	(0.143)	(0.174)	(0.192)
Prop of subsidies* 1rst period							-0.284	-0.315
							(0.517)	(0.630)
Nb of inhabitants per bed	0.826**	0.812*	0.776*	0.760*	0.782**	0.772	0.796**	0.785*
	(0.410)	(0.457)	(0.443)	(0.446)	(0.380)	(0.476)	(0.404)	(0.463)
Net income		-1.59e-05		-1.34e-05	-1.39e-05	-1.01e-05		
		(1.69e-05)		(1.72e-05)	(1.71e-05)	(1.77e-05)		
Initial prop of drug in the income		0.00455*		0.00479*		0.00465*		0.00431**
		(0.00248)		(0.00271)		(0.00278)		(0.00212)
Constant	0.525***	0.360	0.539***	0.345	0.560***	0.336	0.534***	0.367
	(0.140)	(0.227)	(0.144)	(0.265)	(0.149)	(0.283)	(0.143)	(0.233)
Observations	205	197	205	197	203	197	205	198
Number of idt_th	30	29	30	29	30	29	30	29

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Columns 1, 3, 5 7 are random effects models
Columns 2, 4, 6, 8 are Hausman-Taylor regresions

Table 5, Random effects and Hausman Taylor regressions

VARIABLES	(1) efficiency	(2) efficiency	(3) efficiency	(4) efficiency	(5) efficiency	(6) efficiency	(7) efficiency	(8) efficiency
Covered population	0.0335**	0.0354	0.0349**	0.0371	0.0349**	0.0367	0.0348**	0.0350
	(0.0159)	(0.0222)	(0.0174)	(0.0256)	(0.0171)	(0.0225)	(0.0173)	(0.0244)
Subsidies per capita	-0.00155**	-0.000565	-0.000481	0.000245			0.000642	0.000764
	(0.000649)	(0.000906)	(0.00125)	(0.00133)			(0.00132)	(0.00132)
Subsidies per capita*first period							0.00385	0.00373
							(0.00568)	(0.00649)
Prop of licensed staff	0.368	0.402	0.377	0.421	0.478	0.415	0.368	0.246
	(0.288)	(0.387)	(0.340)	(0.422)	(0.322)	(0.397)	(0.325)	(0.399)
Nb of VHC	-0.00376*	-0.00365	-0.00397*	-0.00392	-0.00329*	-0.00390*	-0.00404*	-0.00445*
	(0.00200)	(0.00252)	(0.00221)	(0.00253)	(0.00199)	(0.00232)	(0.00218)	(0.00239)
Staff exp per capita	0.0125	0.0144	0.0113	0.0126	0.0165	0.0133	0.00225	0.00233
	(0.0101)	(0.0123)	(0.0102)	(0.0122)	(0.0110)	(0.0135)	(0.0114)	(0.0130)
Staff exp per capita * 1rst period							0.0183*	0.0156
							(0.0109)	(0.0109)
Prop of subsidies			-0.199	-0.165	-0.126	-0.138	-0.192	-0.230
			(0.202)	(0.218)	(0.151)	(0.154)	(0.191)	(0.198)
Prop of subsidies* 1rst period							-0.422	-0.473
							(0.566)	(0.686)
Nb of inhabitants per bed	0.765**	0.778*	0.725**	0.743	0.731**	0.746*	0.762*	0.776
	(0.367)	(0.402)	(0.352)	(0.455)	(0.349)	(0.412)	(0.444)	(0.480)
Net income		-1.93e-05		-1.76e-05	-2.11e-05	-1.67e-05		
		(1.69e-05)		(1.68e-05)	(1.63e-05)	(1.76e-05)		
Initial prop of drug in the income		0.00457		0.00473		0.00470		0.00408
		(0.00305)		(0.00296)		(0.00328)		(0.00270)
Constant	0.487***	0.362	0.500***	0.353	0.557***	0.349	0.479***	0.354
	(0.136)	(0.287)	(0.154)	(0.298)	(0.172)	(0.328)	(0.155)	(0.281)
Observations	205	197	205	197	203	197	205	198
Number of idt_th	30	29	30	29	30	29	30	29

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Columns 1, 3, 5 7 are random effects models
Columns 2, 4, 6, 8 are Hausman-Taylor regresions

Table 6, descriptive statistics about explanatory variables

variable	mean	min	max	p25	p50	p75	sd
staff - manning staff	4.05	-56	79	-11	0	17	24.14
Inhabitant per bed	0.10	0.03	0.70	0.07	0.10	0.11	0.07
NCMS rb per OP (yuans)	20.605	8.328	57.718	12.929	17.675	23.225	10.451
Income from subsidies	140.56	0	1054.57	16.19	59.49	186.36	195.31
Proportion of subsidies in TH income	17.15	0	69.68	4.23	12.16	26.14	16.45
Subsidies per capita (yuans)	25.10	0	125.48	3.88	11.92	41.51	28.18
Proportion of licensed staff	0.39	0.11	0.66	0.33	0.39	0.45	0.10
Density of Village Health Centers	6.32	1.43	16.86	5.38	6.47	7.46	1.83
Density of covered population	0.05	0.02	0.15	0.04	0.05	0.05	0.02

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